Space Weather Technical Forecast

Issued on Sunday, 25 February 2024 at 01:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-flares expected with a chance of X-flares, and slight chance of associated solar radiation storms. Slight chance of G1/Minor geomagnetic storm mainly day 1 (25 Feb).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate, with the largest flare peaking at M4.5 at 24/0634 UTC from AR3590. There are five numbered spots, however AR3590 remains the largest and most complex region on the disc, by far. Growth of a negative polarity intermediate spot has resulted in this forming a delta spot with the strong positive polarity leader, and smaller delta spots have persisted on the periphery of the region. The other regions are much smaller and simpler, with no significant growth observed.

There were no Earth directed CMEs observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar wind speeds, as observed by ACE at L1, were at background levels throughout, with density average or below for most of the period. There were signs of a weak CME arrival from 24/1617UTC however, with an increase in speed briefly up to 400km/s and density rising to above average, with maximum of 16ppcc. Total Interplanetary Magnetic field (IMF) strength, Bt, was weak, below 7nT, for most of the last 24 hours, but increased to moderate at 24/1617UTC, reaching 11nT. The north-south component varied weakly, between +7nT and -8nT. Phi angle was mainly negative (towards from the Sun), but with brief positive (away from the Sun) spells.

Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux was very slightly above normal background levels, but well below the S1/Minor Radiation Storm threshold. Electron flux (greater than 2MeV) observed at GOES16 has been at normal background levels, with electron fluence well below the Active (1e8 integrated pfu) threshold. The observed 24-hour fluence at 24/0000UTC was 1.0e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Activity is forecast to remain Moderate to High, with occasional M-class flares expected and a chance of further isolated X-class flares from AR3590.

Solar Wind / Geomagnetic Activity: Background solar winds are likely to become enhanced on day 1 (25 Feb), from the onset of the fast wind from CH01/-, before peaking into day 2 (26 Feb). These fast winds easing day 3 (27 Feb). Quiet activity at first becoming Unsettled to Active with a slight chance of G1 Minor Storms from coronal hole fast wind onset on day 1/2 (25-26 Feb). Quiet to Unsettled activity returning day 3 (27 Feb).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux is likely to continue easing near background levels, but with a chance of enhancement due to any significant flares from AR3590, increasing as the region moves into the western hemisphere. High energy electron flux (greater than 2MeV) is expected to persist at background at first. An increase to Moderate or High levels is then possible later in day 2 (26 Feb) onward in response

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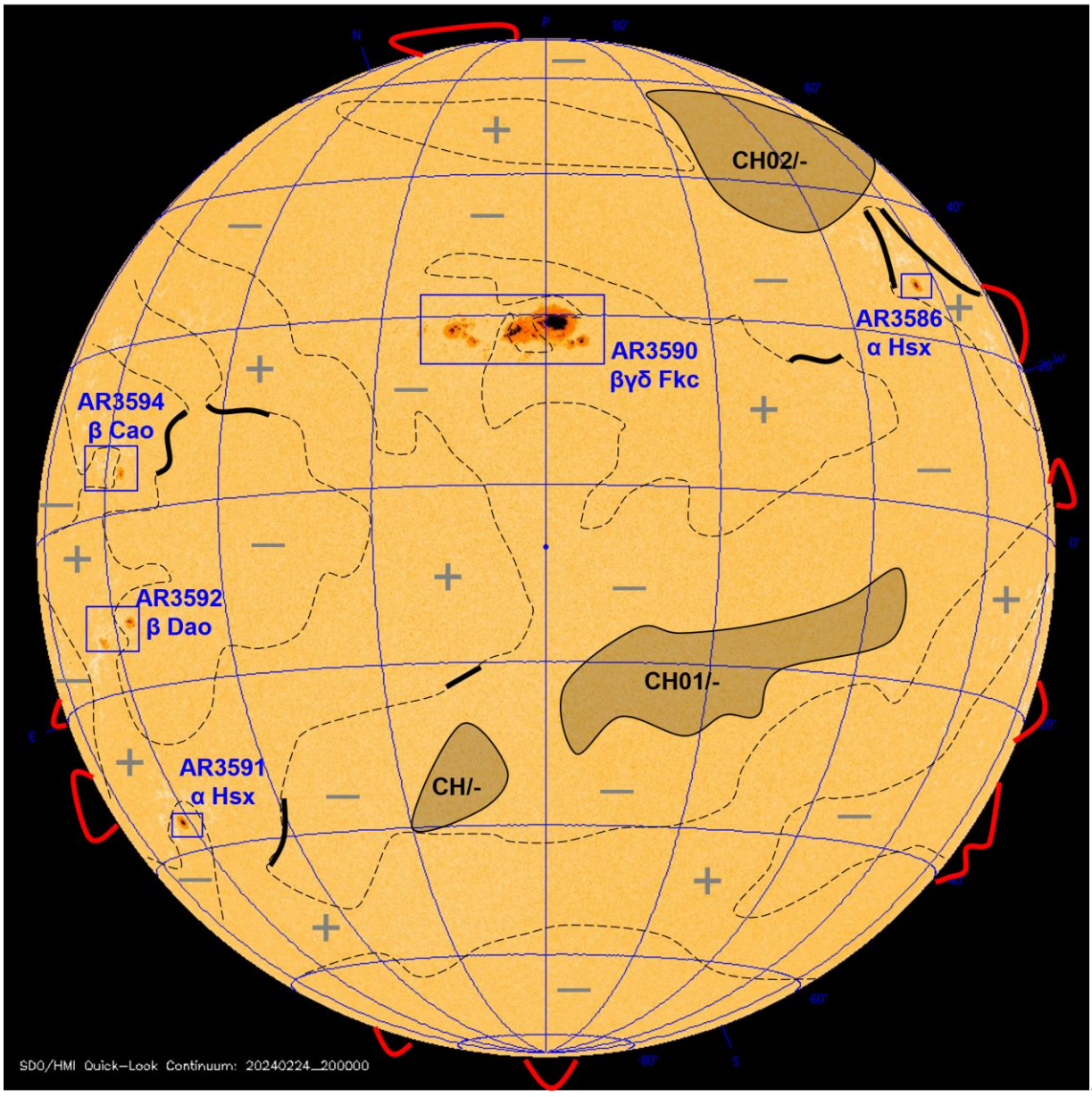
to any solar wind enhancement from the coronal hole fast wind onset. 24-hour electron fluence is expected to stay below the Active (1e8 integrated pfu) threshold, but with a rising trend, giving a slight chance of reaching Active by day 3 (27 Feb).

Figure 1. Solar Analysis Valid24/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The CME from a large filament eruption from the northwest disc around 21/1730UTC is thought to have arrived at L1 at 24/1617UTC, with only weak effects. No other CMEs feature in the current forecast.

Background solar winds are expected to become slightly enhanced later day 1 (25 Feb) due to the onset of the fast wind originating from the western extension of CH01/-. This portion of the coronal hole is similar to the previous rotation, where only a muted response was observed, however the persistence of this coronal hole, alongside the proximity of the March equinox (Russel-McPherron effect), will bring a likelihood of Unsettled to Active geomagnetic activity with a chance of G1 Minor Storm intervals. This enhancement is also supported by MOSWOC Enlil.

The western portion of CH01/- is larger and darker on this rotation however, suggesting a more prolonged enhancement than MOSWOC enlil currently indicates. The fastest portion of the HSS is most likely to be observed later day 1 or day 2 (25-26 Feb), with solar winds potentially peaking 550-600km/s. This will bring an ongoing slight chance of Active to G1 Minor Storm intervals, before easing day 3 (27 Feb) onward.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	20	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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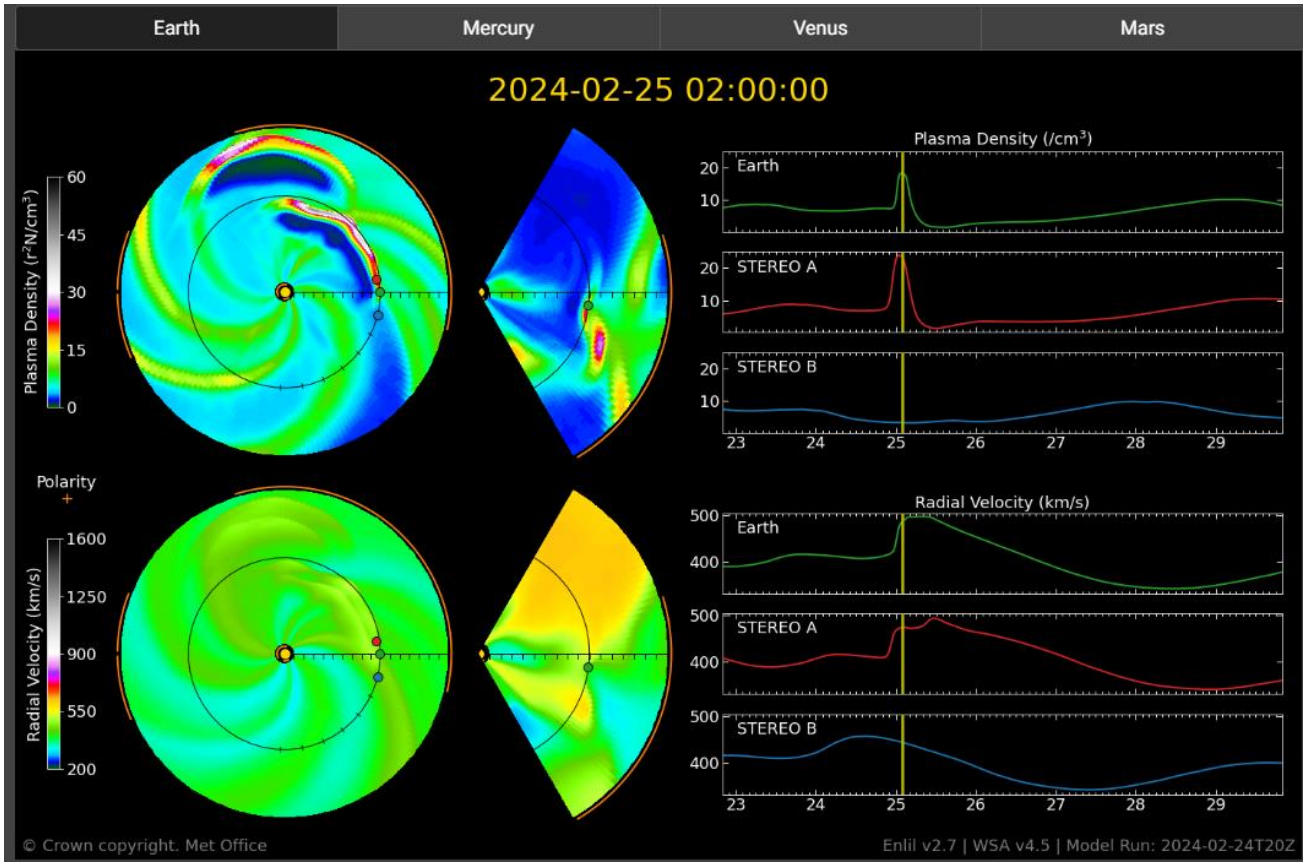
Figure 2: MOSWOC ENLIL 24/2000UTC run. Note that the CME is thought to have already arrived, and the HSS from CH01 may produce a greater enhancement than shown.



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Radio Blackouts - X-Ray Flares:

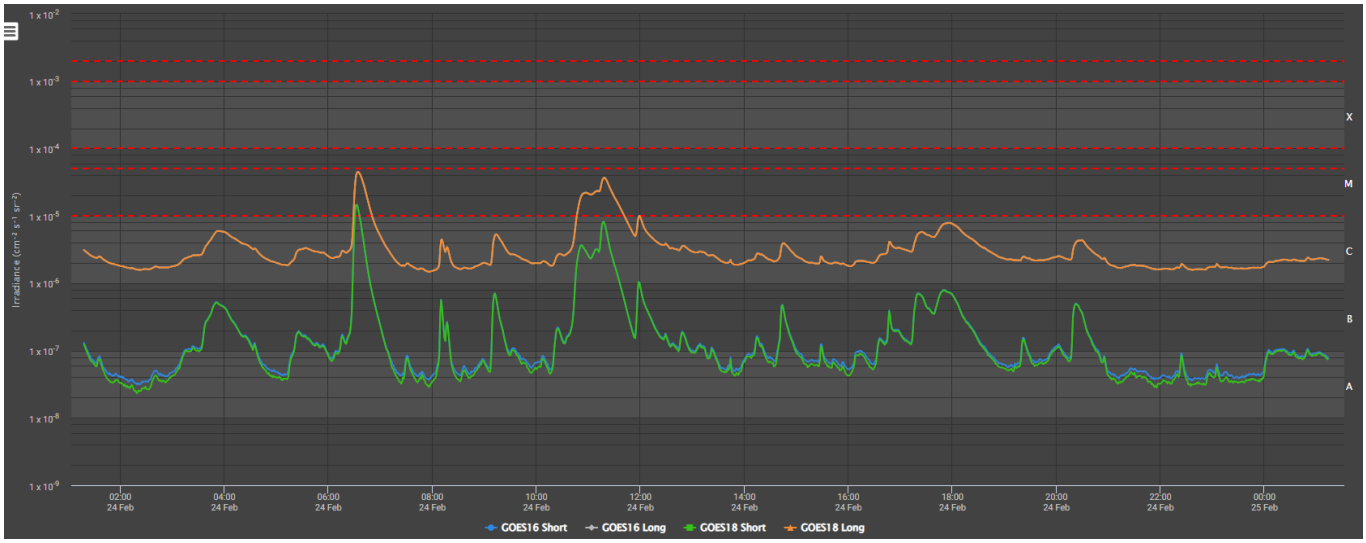
Moderate to High activity is expected, with further M-flares and a chance of isolated X-class flares from AR3590.

AR3590 is a large sunspot in the north-centre disc, and was the source of three X-class flares, including an X6.3 on 22 Feb that was the largest of SC25 so far. Growth of an intermediate spot has resulted in a large delta spot with the strong opposite polarity leader spot, and there are several smaller delta spots elsewhere in the region.

The other spots on the disc are all weaker and in the absence of any notable growth are unlikely to produce significant flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	60
Very Active	R3 to R5 X Class	No	20	20	20	15

Figure 3: GOES16/18 X-Ray Flares



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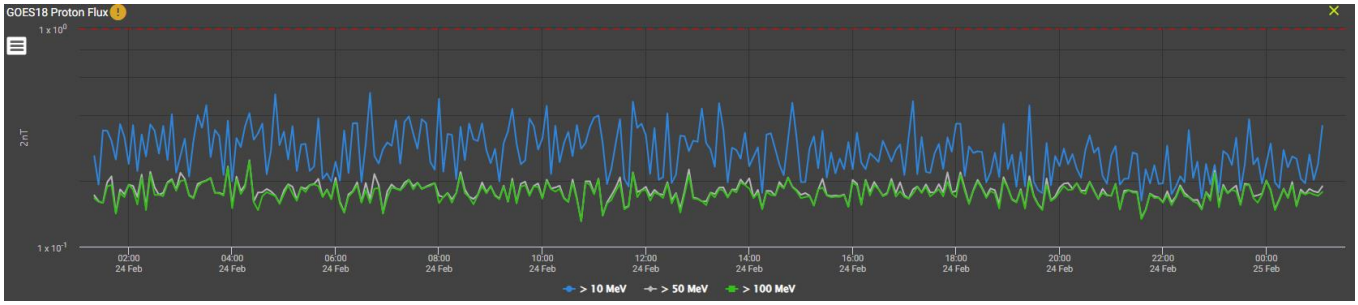
Solar Radiation Storms - (High Energy Protons):

GOES18 high energy (greater than 10MeV) proton flux is slightly above normal background levels, but well below the S1/Minor Radiation Storm threshold. The source of this slight enhancement is only moderate confidence, but most likely due to the lingering effects of the increased flux since 09 Feb. The X-flares of AR3590 are unlikely to have contributed.

However, as AR3590 moves into the western disc any further strong flare activity will bring a chance of enhancing the observed proton flux at GEO, especially if those flares are eruptive. This will bring a chance of reaching S1 Minor Radiation storm levels, with a very slight chance of stronger storms being observed (S2+).

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	20	20
Very Active	**≥ S3 ***	No	1	1	5	5
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES18 Proton Flux



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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES-16 is currently at background. The expected enhancement from CH01/- is likely to increase populations through the Van Allen Belts, however confidence is low with how strong this enhancement will be. Initially observed at lower orbits, any enhanced flux will relax back to GEO through day 2 and day 3 (26-27 Feb), with the observed GOES-16 flux likely becoming Moderate with a chance of reaching High.

The associated 24h fluence is expected to remain below the Active (1e8 integrated pfu) threshold during much of this period, but with a possible rising trend later in the period. This will give a slight chance of reaching Active by the end of day 3 (27 Feb). MOSWOC REFM is showing a below Active trend through the next three days, and will give good guidance in the absence of any coronal hole sourced fast wind or CME enhancement.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES16 Electron Flux (top) and MOSWOC REFM (bottom)

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